

FINDER

FINDING INDIVIDUALS FOR DISASTER AND EMERGENCY RESPONSE

Development, Test, Use

Jim Lux

Jet Propulsion Laboratory

California Institute of Technology

The FINDER Challenge



Photo Credits: Cypress Frwy, USGS H Wilshire; Marina District, USGS J Nakata; CSUN, Ken Fowler; Northridge Apt, Gregory Davis; ground zero 911, US Navy J Watson; Tornado & rest, FEMA;

The Holy Grail of Urban Search and Rescue (SAR)

“Walk down a street with collapsed buildings and readily determine which have live humans in them!”

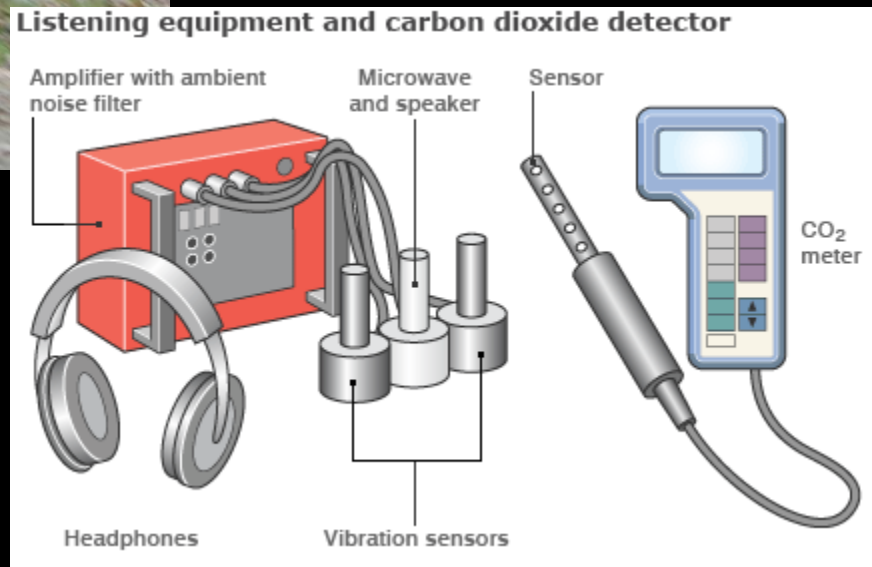


Time spent searching is lives saved or lost!

How SAR teams do it now

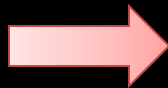


Topas – Photo courtesy John Price



Courtesy BBC

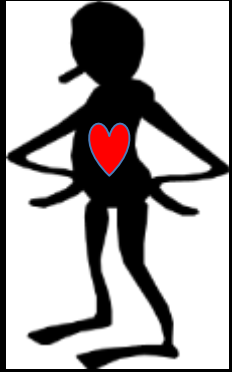
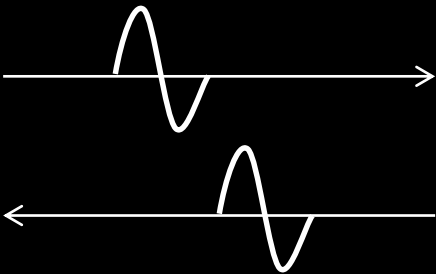
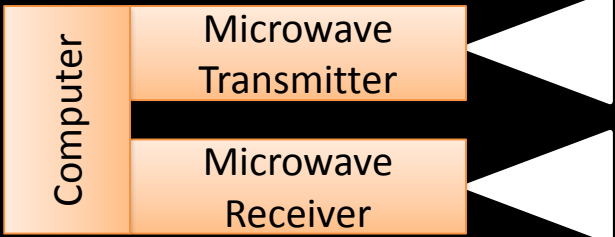
- DHS wanted 80% solution today, not a 100% solution in 5 years
 - Existing search techniques aren't 100%
 - New approaches that are complementary to existing approaches, not replacements
- JPL had technology that can get us there
 - Microwave Sensing of Human Vital Signs
 - Just another remote sensing problem, isn't it?
- Project started in April 2012, first prototype tests in Apr 2013 revised prototypes tested in June 2013, September 2013
 - Lots of press coverage of September 2013 – led to requests for FINDER use all over world
- Field Tests in 2014
 - Disaster response exercises and testing all over the US

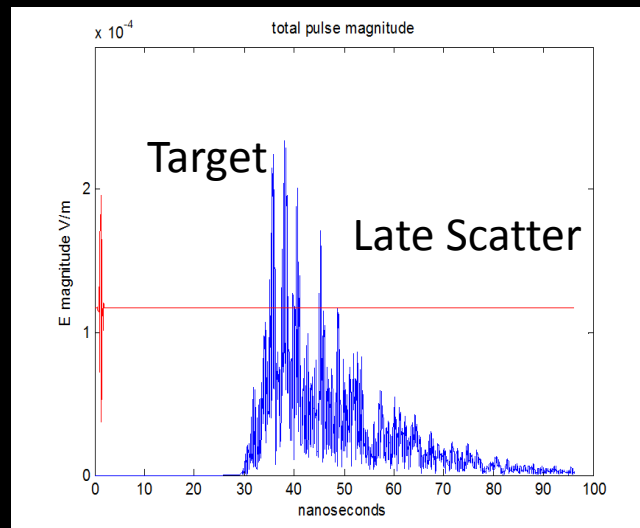
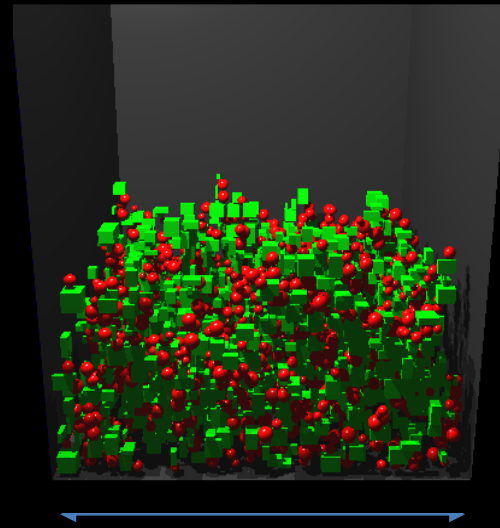
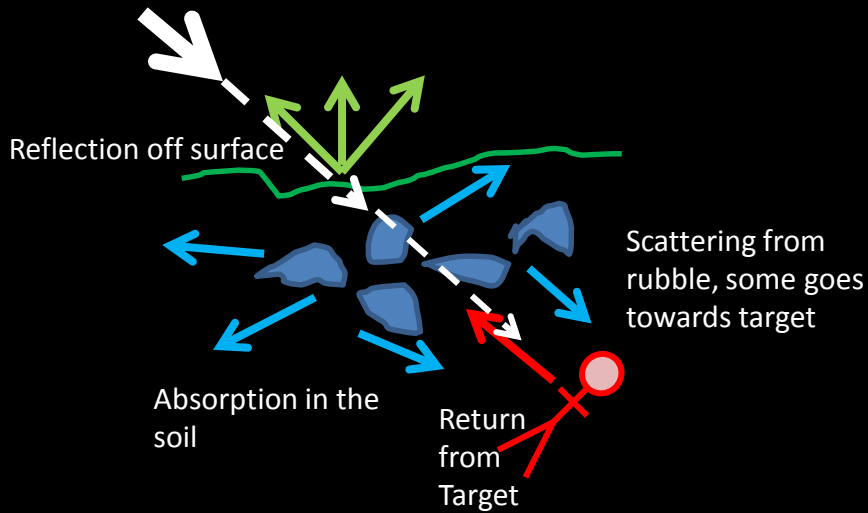






USGS



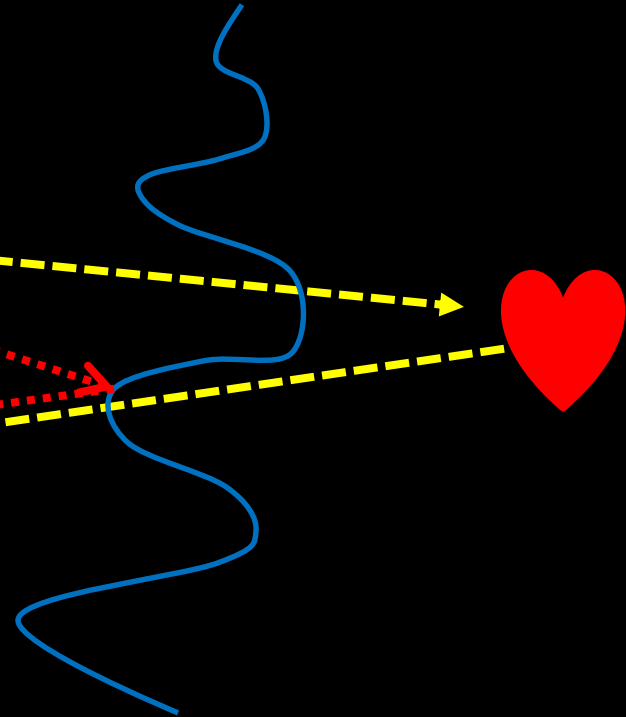
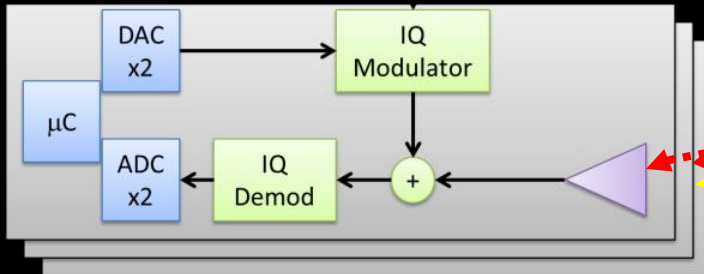
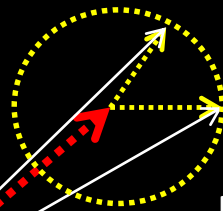




Big component from fixed clutter and Tx Rx antenna coupling

Small changing component from heartbeat & breathing. Constant amplitude, variable phase

Radar sees the vector sum
Large constant component + small varying component
-> small phase change



Big component from fixed clutter

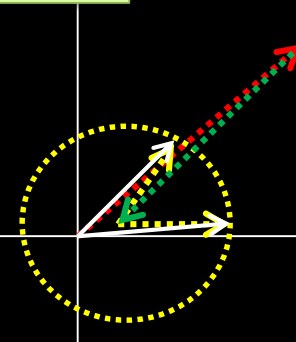
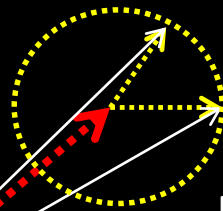
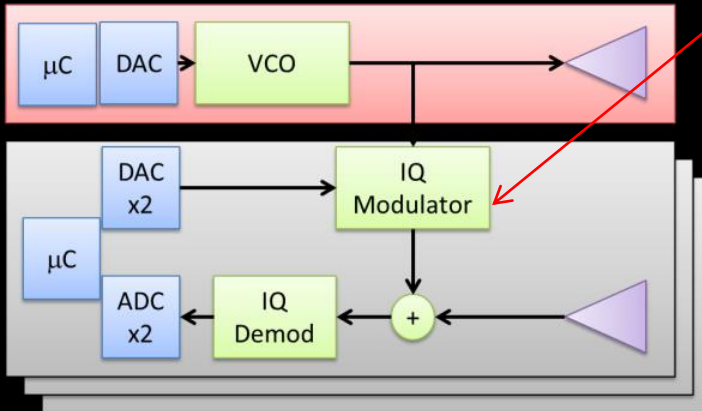
Small changing component from heartbeat & breathing. Constant amplitude, variable phase

Radar sees the vector sum
Large constant component + small varying component
-> small phase change

Subtract estimate of fixed component

Clutter is mostly cancelled

Now radar sees much larger phase & amplitude variation (as fraction of total signal)
Dynamic range is restored



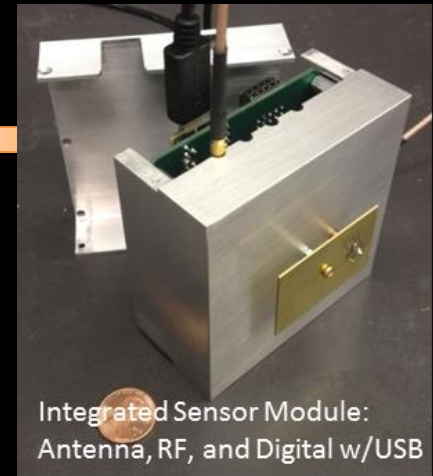
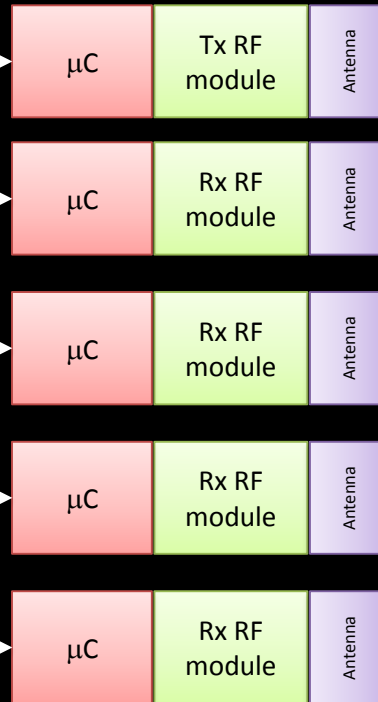


WiFi
PC for
target
detection

Batteries

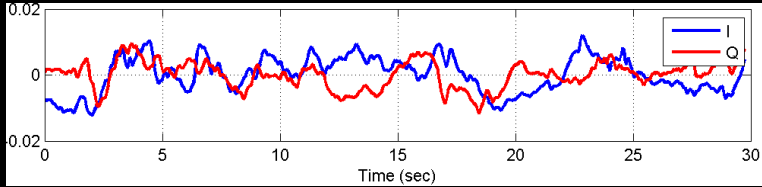
Camera
GPS

USB



Integrated Sensor Module:
Antenna, RF, and Digital w/USB

Microwave Sensors



Feature Extraction

	freq	SNR	BW	FM F
Breathing				
	10	29.2		
	15	22.8		
	36	16.6		
Heart				
	62	15.3	0.024	10
	76	16.0	0.025	17
	94	9.8	0.023	20

Rules that define "what is human" and "what is not human"
 $40 < HR < 130$

Detection

Rel Heart Resp
84 % 62 10

Search done at 24-Sep-2013 08:29:06



Rel	Heart	Rel	Resp
None	None	None	None

Search done at 24-Sep-2013 11:39:14

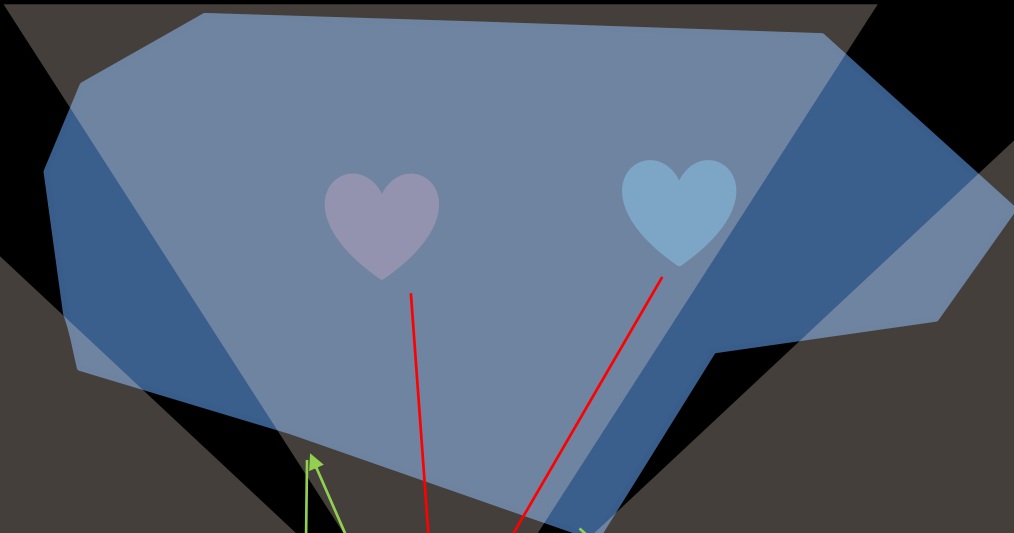


Rel	Heart	Rel	Resp
86 %	90	94 %	17

Search done at 24-Sep-2013 07:45:18



Rel	Heart	Rel	Resp
86 %	65	98 %	14
85 %	79	92 %	9



Search done at 24-Feb-2015 11:48:08

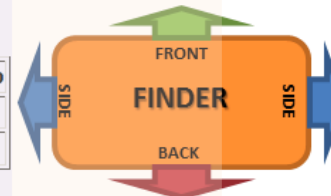
GPS location:40 42.5800N,074 10.3541W (?)

Beam 1 data

Rel	Heart	Rel	Resp
59 %	69	97 %	21
82 %	96	92 %	13

Beam 3 data

Rel	Heart	Rel	Resp
85 %	74	96 %	17
84 %	91	95 %	12



Beam 4 data

Rel	Heart	Rel	Resp
85 %	85	98 %	10

Beam 2 data

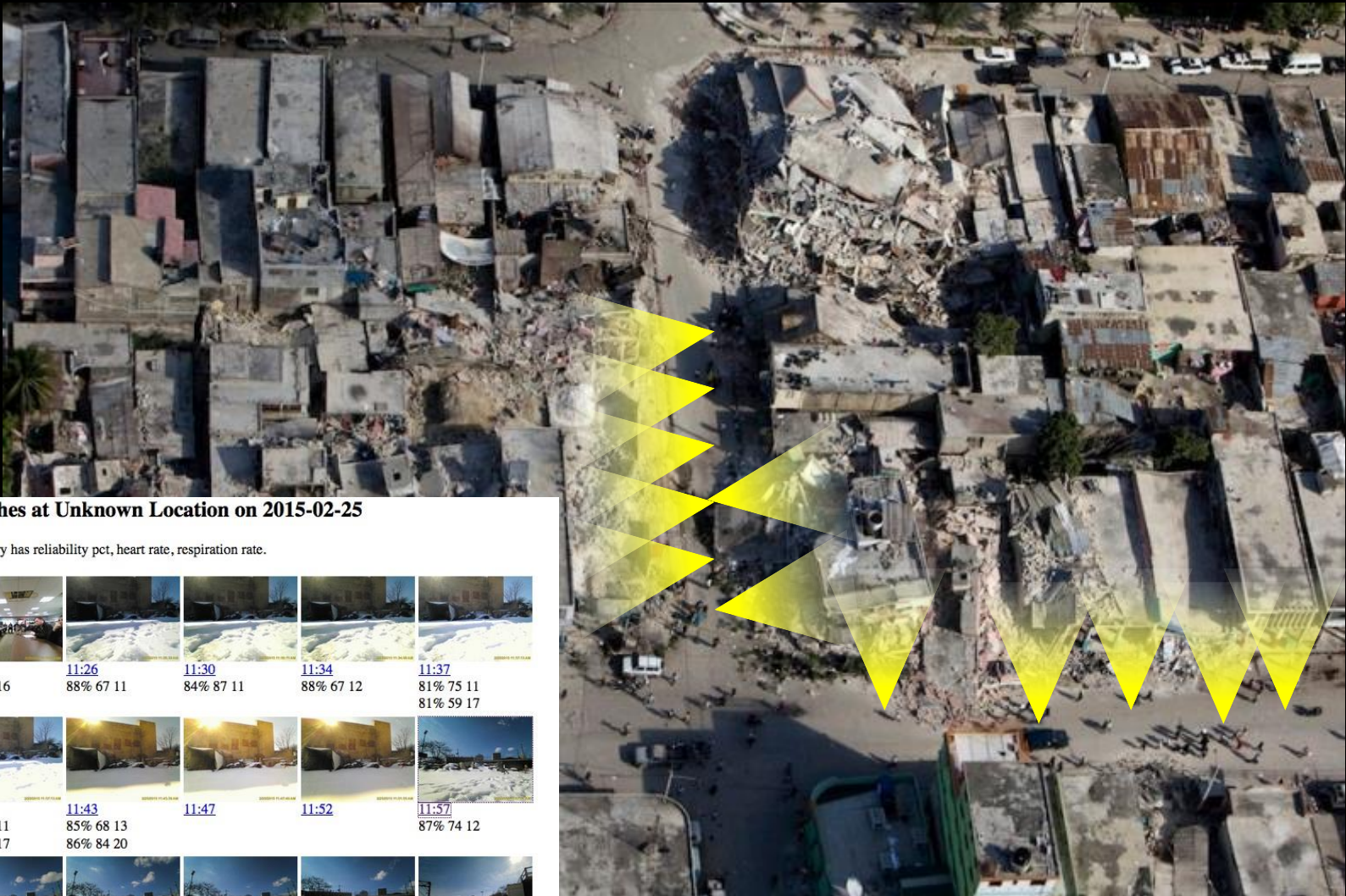
Rel	Heart	Rel	Resp
89 %	63	96 %	12

Detailed Analysis Logs: [Beam1](#) [Beam2](#) [Beam3](#) [Beam4](#) [All Beams](#)

Final Remarks :

Number of victims out of estimated targets in front is 2

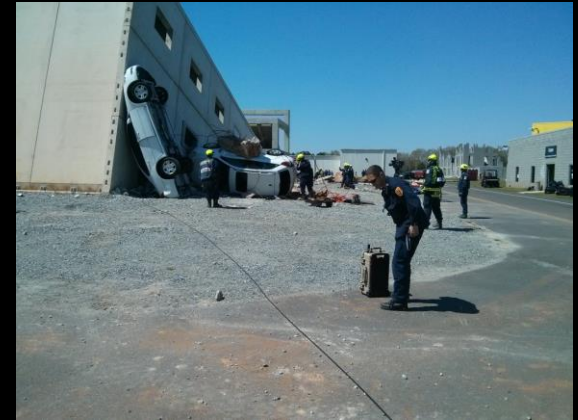
Number of probable bystanders/on-the-side targets out of estimated ones in front is 0

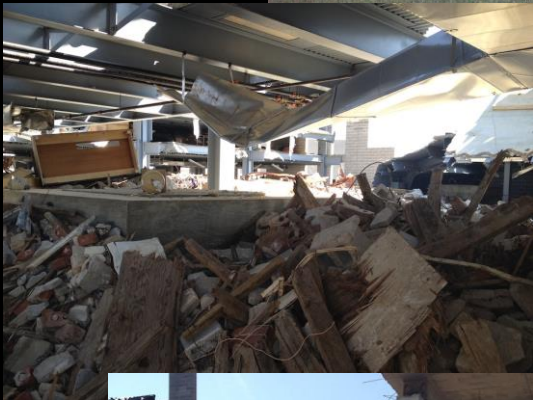


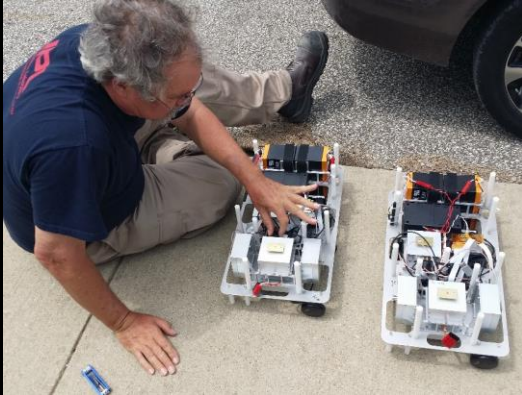
Searches at Unknown Location on 2015-02-25

Each entry has reliability pct, heart rate, respiration rate.

11:11 83% 56 16	11:26 88% 67 11	11:30 84% 87 11	11:34 88% 67 12	11:37 81% 75 11 81% 59 17
11:39 81% 75 11 81% 59 17	11:43 85% 68 13 86% 84 20	11:47	11:52	11:57 87% 74 12
12:00 83% 83 12	12:02	12:06	12:08 81% 73 13	12:15 92% 96 12







Algorithms from Space
Science and Radar

Components from
Wireless Industry

Small, Fast Battery
Powered Computers



FINDER
Prototype

Industry

YOU





From USGS ENS★

Subject 2015-04-25 06:11:25 (M7.5) NEPAL 28.2 84.7 (7d66b)

To jimlux@earthlink.net★

M7.5 - NEPAL

Preliminary Earthquake Report

Magnitude	7.5
Date-Time	25 Apr 2015 06:11:25 UTC 25 Apr 2015 11:56:26 near epicenter 24 Apr 2015 22:11:25 standard time in your timezone
Location	28.165N 84.725E
Depth	11 km
Distances	35 km (22 mi) E of Lamjung, Nepal 60 km (37 mi) NNE of Bharatpur, Nepal 75 km (47 mi) E of Pokhara, Nepal 76 km (47 mi) NW of Kirtipur, Nepal 77 km (48 mi) NW of Kathmandu, Nepal
Location Uncertainty	Horizontal: 8.5 km; Vertical 4.0 km
Parameters	Nph = 117; Dmin = 1251.9 km; Rmss = 1.08 seconds; Gp = 35° M-type = mwb; Version =

Timeline (EDT)

- Day 1 – 25 April (Sunday)
 - 1:11 AM – Earthquake occurs
 - 6:30 PM – VA-TF1 notified of deployment
 - 11:40 PM – USA-1 leaves cache
- Day 2 – 26 April (Monday)
 - 2:30 AM - USA-1 in flight
- Day 3 – 27 April (Tuesday)
 - 4:20 AM – USA-1 in Doha, Qatar for refuel
 - 3:50 PM – David Lewis from R4 is in Abu Dhabi with a FINDER
 - 7:30 PM - USA-1 arrives in Nepal (5:15AM local)
- Day 4 – 28 April (Wednesday)
 - USA-1 sets up camp and starts search and rescue
- Day 5 – 29 April (Thursday)
 - 2:34 AM – (noon in Nepal) David Lewis rendezvous with USA -1
- Day 6 – 30 April (Friday)
 - David Lewis heads out to Chautara
 - assists Belgian, Chinese, Netherlands and Nepali Army teams and finds 4 victims



USAR team equipment is prepackaged on pallets. They're ready go, 2 hours later.



Photos courtesy David Lewis, R4 Inc.

SCIENCE NEPAL EARTHQUAKE MAY 7 2015, 4:08 PM ET

Nepal Earthquake: How NASA Technology Found Buried Victims

Hunting for heartbeats: NASA technology rescues 4 quake survivors in Nepal



earthquake hit Nepal on April 25 to detect the heartbeats of four rescue. The gadget is called Finder (Emergency Response), and it employs measure the orbit of satellites ci

and government officials gathered at the Force One Training Facility in Lorton, Virginia, to talk about. "The tri SCIENCE

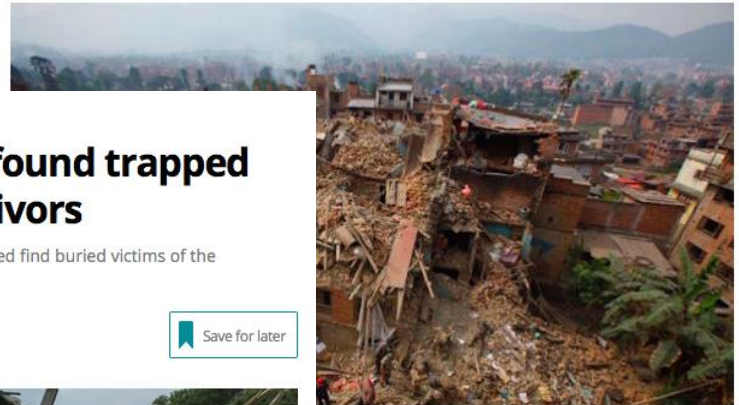
NASA's Radar Found 4 Men Trapped in Rubble in Nepal By Their Heartbeats



Sarah Zhang

Filed to: NEPAL EARTHQUAKE 5/06/15 11:35am

165,537 47 ☆



NEPAL EARTHQUAKE

NASA, JPL DEVELOP LOW-POWER RADAR FINDER TO LOCATE EARTHQUAKE SURVIVORS



NASA technology found trapped earthquake survivors

of hardware that detects heartbeats helped find buried victims of the

laCasse, Staff Writer | MAY 11, 2015



Finder, a low-power radar technology developed by minds at the Jet Propulsion Laboratory in Pasadena and NASA, helps to locate earthquake survivors under the rubble.

Thank you to everyone who helped develop FINDER